MAR 18 1897

5

ELECTRIC VEHICLES NUMBER.

Entered as matter of the second class at the New York, N. Y. Post Office, November 26th, 1890.

VOLUME XIV. NUMBER 1.

[COPYRIGHT, 1897.]

JANUARY, 1897.

Annual Subscription $5.00
Single Copies - .50

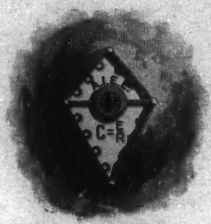
TRANSACTIONS

OF THE

AMERICAN INSTITUTE

OF

ELECTRICAL ENGINEERS.



CONTENTS.

	PAGE.
Associate Members Elected January, 20th, 1897	1
ELECTRICALLY DRIVEN VEHICLES.	
A Topical Discussion, January 20th, 1897.	
Remarks by Mr. A. L. Riker....3, 4, 7, 8, 14,	21
" " Dr. Louis Duncan....4, 6, 8,	17
" " Mr. F. Reckenzaun	4
" " Mr. Adams	5
" " Mr. H. B. Coho....5,	8
" " Mr. Joseph Sachs....6, 9,	15
" " Mr. W. R. C. Corson	6
" " Mr. H. Van Hoevenbergh	16
" " Mr. C. E. Duryea....17,	23
" " Mr. R. W. Pope	24
Advertisements	25

PUBLISHED BY THE INSTITUTE, UNDER THE SUPERVISION OF THE COMMITTEE ON PAPERS AND MEETINGS.

RALPH W. POPE, *Secretary*,
26 CORTLANDT STREET, NEW YORK CITY.
Telephone, 2193 Cortlandt.

Next Meeting, Wednesday, March 24th, Postponed from 17th.

OFFICERS AND MEMBERS OF THE COUNCIL.

1896-97.

PRESIDENT:

DR. LOUIS DUNCAN,
Term expires 1897.

PAST-PRESIDENTS:

DR. NORVIN GREEN, 1884-5-6.
FRANKLIN L. POPE, 1886-7.
T. COMMERFORD MARTIN, 1887-8.
EDWARD WESTON, 1888-9.
PROF. ELIHU THOMSON, 1889-90
PROF. W. A. ANTHONY, 1890-91
ALEX. GRAHAM BELL, 1891-2.
FRANK J. SPRAGUE, 1892-93.
DR. EDWIN J. HOUSTON, 1893 4-5.

VICE-PRESIDENTS:

Terms expire 1897.
ANGUS S. HIBBARD,
DR. MICHAEL I. PUPIN,
W. F. C. HASSON.

Terms expire 1898.
CHARLES P. STEINMETZ,
PROF. HARRIS J. RYAN,
PROF. WILBUR M. STINE.

MANAGERS:

Terms expire 1897.
A. E. KENNELLY,
WILLIAM D. WEAVER,
CHARLES S. BRADLEY,
W. B. VANSIZE.

Terms expire 1898.
CHARLES F. SCOTT,
BION J. ARNOLD,
CARL HERING,
DR. CARY T. HUTCHINSON.

Terms expire 1899.
JOHN W. LIEB, JR.,
F. A. PICKERNELL,
WILLIAM L. PUFFER,
L. B. STILLWELL.

Terms expire 1897.

TREASURER:
GEORGE A. HAMILTON,
32 Thames Street, New York.

SECRETARY:
RALPH W. POPE,
26 Cortlandt St., New York.

Board of Examiners:

CHARLES E. EMERY, Chairman.
WILLIAM MAVER, JR.
JAMES B. CAHOON,
TOWNSEND WOLCOTT.

Standing Committees appointed by direction of Council:

Executive Committee:

DR. LOUIS DUNCAN, Chairman.
GEO. A. HAMILTON,
DR. CARY T. HUTCHINSON,
A. E. KENNELLY,
R. W. POPE,
DR. M. I. PUPIN,
W. B. VANSIZE.

Committee on Papers and Meetings.

HERBERT LAWS WEBB, Chairman.
DR. LOUIS DUNCAN, DR. CARY T. HUTCHINSON, T. C. MARTIN
A. E. KENNELLY, DR. M. I. PUPIN.

Finance Committee:

W. B. VANSIZE, Chairman,
G. A. HAMILTON,
F. A. MERRILL,
W. D. WEAVER.

Committee on Units and Standards.

A. E. KENNELLY, Chairman. GEO. A. HAMILTON, DR. WM. E. GEYER,
FRANCIS B. CROCKER. WILLIAM D. WEAVER.

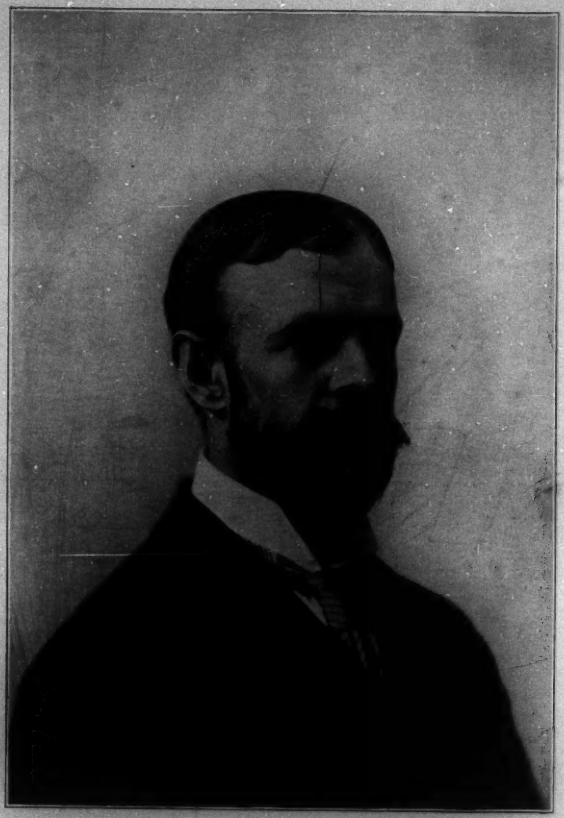
Committee on Membership, etc.,

RALPH W. POPE, Chairman.

THOMAS D. LOCKWOOD, Local Secretary,		Boston, Mass.
DR. LOUIS DUNCAN,	"	" Baltimore, Md.
CARL HERING,	"	" Philadelphia, Pa.
PROF. EDWARD L. NICHOLS,	"	" Ithaca, N. Y.
R. N. BAYLIS,	"	" Cleveland, O.
JOSEPH WETZLER,	"	" New York City.
H. A. FOSTER,	"	" Buffalo, N. Y.
DR. F. A. C. PERRINE,	"	" Palo Alto, Cal.

PROF. WILBUR M. STINE, Local Honorary Secretary,
Armour Institute, Chicago, Ill.

Vol. I
1897



Francis B. Crocker

TRANSACTIONS

OF THE

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Vol. XIV. JANUARY TO DECEMBER. 1897.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

NEW YORK, January 20th, 1897.

The 112th meeting of the INSTITUTE was held this date at 12 West 31st Street, and was called to order by President Duncan, at 8.30 P. M.

Secretary Pope read the following names of associate members elected at the meeting of the Executive Committee in the afternoon.

Name.	Address.	Endorsed by.
BATES, PUTNAM A.	Student, Columbia University; residence, 113 West 72d St,, N. Y. City.	F. B. Crocker. Geo. F. Sever. W. H. Freedman.
HERMESSEN, JOHN LOUIS.	Chief of Data Dept., Union Elektricitats Gesellschaft, Kleist Strasse Berlin, Germany.	John B. Blood. Harold Hakonson F. C. Bates.
HOMMEL, LUDWIG.	Supt. of Construction, Standard Underground Cable Co., Westinghouse Building, Pittsburg, Pa.	Henry W. Fisher Geo. S. Bliss. Wm. D. Gharky.
KENAN, WM. R. JR.	Chemist and Electrical Engineer, Australian Carbide Co., Sydney, N. S. W.	E. F. Price. W. K. Dunlap. Paul M. Lincoln
MACGREGOR, WILLARD H.	Draughtsman, 359 West 27th St., New York City.	Louis Duncan. Frank J. Sprague C. T. Hutchinson.
RICE, CALVIN WINSOR.	Consulting Electrical Engineer, 8 Eaton St., Winchester, Mass.	C.T. Hutchinson E. W. Rice, Jr. Louis Bell.
RICH, FRANCIS ARTHUR.	Consulting Mining and Electrical Engineer, Auckland, New Zealand.	Jos. N. LeConte. Clarence L. Cory Jas. A. Lighthipe

STAKES, D. FRANKLIN,	Electrical Expert, The Fort Wayne Electric Corporation; residence, 240 West Washington St., Fort Wayne, Ind.	F. S. Hunting. Thos. Duncan. E. A. Barnes.
TOWNSEND, SAMUEL G. F.	Electrical Engineer in Testing Department, with Ward Leonard Electric Co., Hoboken, N. J.; residence, 131 Fifth Ave., N. Y. City.	Geo. F. Sever. H. Ward Leonard A. W. Berresford

Total 9.

THE PRESIDENT:—The discussion this evening will be on Electrically Driven Vehicles. The subject will be opened by Mr. Riker.

A Topical Discussion at the 112th Meeting of the American Institute of Electrical Engineers, New York, January 20th, 1897. President Duncan in the Chair.

ELECTRICALLY DRIVEN VEHICLES.

(A Topical Discussion.)

MR. ANDREW L. RIKER:—In opening a discussion on electrically driven vehicles, at this time, I feel as if the electric carriage had arrived at a period of transition, that is, it is passing from the experimental into the practical stage. I think that it is generally admitted that the electric carriage is the ideal vehicle, having all the advantages of simplicity, ease of control, and free from heat, vibration, or odor, but there is one element in the electric vehicle that we must not lose sight of, which has caused all experimenters in this line their greatest trials—that is—the storage battery.

This vital part of the system has been defective, and upon the remedy of this defect depends the success of the electric vehicle. This defect is not that the storage battery is not a practical apparatus, but that it has not been adapted to the particular requirements in this case.

The weight of a motor vehicle must be kept within certain limits. To that end the battery portion has had to be lightened and under the same conditions it has had to withstand heavy discharges from 100 per cent. to 1,000 per cent. above the normal rate. To meet these requirements some special form of cell must be devised.

I have corresponded with most of the prominent battery companies both on this side and abroad, and find the best output obtainable for complete cell including hard rubber jar, acid and element, sealed in, is about five and one-half watt hours per pound. This value limits the run from four to five hours on each charge, at a 10-mile pace.

If there is present any representative of the storage battery interests, I should be glad to hear whether they have anything new for this service. I had hoped to be able to give the results of a complete set of tests on a new vehicle upon which I am now engaged, but the carriage is not finished.

My experience with my first two carriages, both of which were

supplied with a double motor equipment, has shown that a single motor is preferable. The single motor equipment is much more sightly, and the motor and gears can be placed under the middle of the body and out of sight. The bicycle construction, wire spokes, pneumatic tires and tubular gear I believe are necessary to a successful vehicle. Equally necessary if the vehicle is to give satisfaction, is simplicity of control.

At the present time the electric carriage is not eminently suited for long runs, or out-of-town service, but for this we anxiously await what the future may bring forth.

THE PRESIDENT:—This question of motor vehicles is one of the most important, next to the development of railroad traction, which is before electrical engineers. The success of it depends upon what we can do with storage batteries. Mr. Riker's results of five to six w. hrs. per lb. seems to me better than the ordinary battery will do under the conditions imposed on them. As I have said, tests made by cyclometers show that few vehicles made as much as 30 miles a day, and it is only very rarely that they go as high as 35 miles a day.

The results given in the ordinary battery catalogues show that no battery is now on the market that will drive a motor carriage more than 20 to 25 miles with a reasonable weight of battery. The results as given by Mr. Riker will enable the vehicle to travel something over 30 miles, and I am glad that such results are being obtained. I know myself that there are several batteries that give results better than those on the market, but they have not been developed to that point where they can be commercially exploited. It seems to me that the question is whether some of these batteries can be developed so they will give with comparatively small depreciation a capacity to drive a vehicle 30 to 35 miles. If they can do this they will be a success; if they cannot they will be a failure. If any one in the audience can give us some data on this point I will be very glad to hear it.

May I ask Mr. Riker what batteries he was referring to?

MR. RIKER:—I was referring to the 3-M. chloride battery. I believe they guarantee a thousand discharges on that cell at a three and a half hour rate.

MR. F. RECKENZAUN:—I am hardly prepared to discuss electric vehicles by way of adding new and valuable information on the subject, but I may confirm Mr. Riker's statement to the effect that the best storage batteries available would only give about five and a half watt hours per pound, gross weight. A battery may be constructed to give six, seven or eight watt hours per pound, but it would hardly be considered satisfactory for the purpose in point of durability. In general, I think that vehicles propelled by means of storage batteries could be made a success for short trips—for city work, such as advertising carriages and the like. But for long-distance travel I do not think the time has arrived when it would be worth while to even go into experi-

menting. The results which have been obtained on the other side with gasoline motors and motors of similar kind are so far ahead of what could possibly be accomplished by means of storage batteries as to practically settle the question in my mind that long-distance propulsion is not a promising field for the storage battery we are now capable of producing.

MR. ADAMS:—I merely came here this evening to hear the general discussion on the subject, without making any preparation with a view of giving you any detailed information. The Electric Carriage and Wagon Co. are equipping a station in New York for the purpose of running a dozen or more electric carriages for public and private service in order to demonstrate quickly the commercial side of the question. As this is probably the first station of the kind that ever was equipped, a number of new problems are constantly arising, and it will be some months before we can speak with any degree of accuracy as to what the probable results will be. The service at first will be more or less selective, as we do not propose to try to do impossibilities or impracticabilities. As to what has occurred in the past year I can speak with more confidence. We have constructed a carriage that has travelled 35 miles on one charge through the streets of Philadelphia, no particular route being selected, and the ordinary conditions of city travel, such as grades, railway crossings, and the various kinds of pavements being met with. We have made with this carriage during the past year about 1,000 miles, and have covered this distance with but a single accident, which only caused a delay of about five minutes. The carriage has had to travel over all sorts of streets and roads in Philadelphia, New York, Providence and Chicago. This carriage is in the form of a surrey, and is not adapted for public use. Those that we are now constructing (the first of which is already in New York) are built on the principle of a four-wheeled hansom; that is to say, the front part of the vehicle is exactly the same as the ordinary hansom with which you are familiar, and there is a box extending from the rear on which the driver's seat is mounted, and which box is carried on the rear wheels and intended to carry the battery. We expect to make with these hansoms and coupes from 15 to 20 miles on one charge, which we consider more than sufficient to meet all the requirements of city service. They are not intended to take long trips out into the country, and we will not attempt to use them for this purpose. Almost any point in New York or vicinity can be reached within a radius of 7½ miles from Thirty-ninth Street and Broadway, and on returning from a 15-mile trip it is only necessary to change the batteries, which is an operation requiring but a few minutes, when the vehicle will be ready for another 15 miles. This vehicle weighs about 2,500 lbs. The cells which we use are 44 in number and have a capacity of about 70 ampere-hours at a two-hour and one-quarter rate of discharge. That is to say, they will give 30 amperes for

two hours and one-quarter, and a correspondingly increased amount for lower rates. As it requires about 25 amperes to run on levels at a speed of about nine miles an hour, it will readily be seen that we will have a capacity of at least 20 miles on levels and 15 miles over any conditions that we will probably meet in New York. The battery, including the rubber jars, acid, and retaining boxes, weighs about 1,000 lbs.

THE PRESIDENT:—I have talked with people who have spent a great deal of time and money on the question of motor vehicles, and who have tried oil, compressed air and gasoline for motive power. Their idea is that it is almost impossible to make a motor carriage that can be turned over to any driver—one who knows nothing about mechanics—and obtain successful results. The heat, the smell and other disadvantages were such that the company referred to gave up experiments with everything but storage batteries. The most extensive fields for motor vehicles is in large cities, where the batteries can be charged at night and where long trips are not required. The experience with storage batteries has been that if they are never fully discharged, but always have a partial charge, the depreciation is not high and their efficiency is satisfactory. If, however, they are discharged completely, the depreciation is very high and efficiency is low. Now the question, to my mind, is whether we have reached such a condition of affairs that any battery made will allow a motor carriage to be run say 30 to 35 miles and still retain some charge in the battery. I would be glad to hear from any one who has had practical experience with storage batteries as to their present status.

MR. H. B. COHO:—Some years ago I had considerable experience with storage battery cars and found that with our tracks in good condition we could run fifty miles on one charge, but when our tracks were dirty we ran but ten miles on the same charge. I think that if I were intending to use a storage battery carriage I should want to use a meter, which after a certain number of watt hours had been expended, would ring the bell and give warning that it was time to return. I have yet to see the battery, which on one charge I would feel certain of making more than thirty or forty miles with.

THE PRESIDENT:—It depends largely on what you have in your storage battery carriage.

MR. CORSON:—I would like to say that in a motor carriage which I have had the privilege of examining—an electric carriage—I have seen the meter which Mr. Coho describes as necessary, which tells the man to go home.

THE PRESIDENT:—If it is only the driver, I think it is all right. But there may be other people, who wish to go on.

MR. JOSEPH SACHS:—I think a discussion probably of the various features that enter into the construction of a motor carriage in general might be of interest. Mr. Riker, for instance,

has built a vehicle possessing a number of very peculiar features, and the discussion of these features and others might be interesting. There is a great deal more than the mere furnishing of power in the successful motor vehicle; and while probably the power may be over 50 per cent., still the other factors are very important.

MR. RIKER:—In reply to Mr. Sachs I would say that there is, of course, a great deal more in the electric carriage than just simply the storage battery. But my object was to see if we could not get somebody in the storage battery line to make an improvement there. We think that the rest of the carriage is all right.

MR. SACHS:—If you look at it from the electrical side.

MR. RIKER:—Of course the horseless vehicle must be built differently from the vehicles we have been accustomed to, drawn by horses. In the first place is is a vehicle that carries its own propelling power and relies on traction to take it over the ground, and there is no necessity, so far as I can see, of building a high vehicle. Our new designs, in fact, call for a low vehicle. We also advocate the use of small wheels, using in our new machine 36-inch rear wheels and 32-inch front wheels. I had hoped to be able by this time to give the data on our new carriage; but as I said before, it is not finished yet, through delays of construction and other causes. But our object has been to produce a small, light electric vehicle that has a range of about forty miles on a single charge of the battery. A vehicle constructed for this work, with a capacity of two passengers and an average speed of ten miles an hour over ordinary roads will weigh, complete, about 1400 pounds. Of course, the principal weight here is the battery. We advocate the use of pneumatic tires and large ones, and the simplest form of running gear—single motor equipment—and we are trying on our new machine a device that is practically on the order of a back gear on a lathe, so that when we strike snow or very heavy grades, instead of taking too heavy a discharge on our battery, we can run our motor at its highest economy and reduce the speed of our vehicle to such a point that we will get the best results. This is all operated automatically, so that there is a simple lever to make all the changes. We also believe that the electric carriage, as Mr. Coho said, has to be operated nearly automatically and to take care of itself. We have tried to make this one so; so that in case a man happens to get a little tired and runs the carriage up against a stone wall or something, forgetting to turn off the current, that the batteries will not stand and discharge and the first thing we know we have a wreck. We have provided a device that takes care of that. Also, in case he gets rattled and forgets to cut off the current and put on the brake, which is sometimes done at close quarters, it will cut the current off and bring the carriage to a stop. I know of an electric vehicle now that is

being made in which they are trying to overcome that difficulty of running out of a charge, and in fact I believe they have it arranged so that an instrument on the dashboard indicates when it is time to go home. It shows the amount of current left and the amount of current consumed. The same device, I believe, when in charging, puts the required amount, over and above what has been taken out of the batteries, back; so that the machine can be looked after by anybody, and the question of putting 25% more in than has been drawn out is not necessary. It is attended to automatically. The steering gear in a motor carriage is another point that is sometimes overlooked. There have been a great number of very peculiar devices proposed. I think the general tendency is to adopt the style of hinging the wheels at the hub, or pivoting the wheels at the hub, so that the two wheels turn on their own indepenent steering head or fifth wheel, avoiding any of the great leverage exerted by a fifth wheel device, in which when one wheel strikes a rock or obstruction tends to throw the carriage from its course. Our new device is such that we can, in fact, go over an obstruction of three or four inches with one wheel, nothing under the other, without a tendency to throw the wheels whatever.

I do not know what other points there are to bring up. But I think there are some gentlemen here who could give us some interesting data, if not on the electric, on the gasoline vehicle.

MR. COHO:—I should like to ask Mr. Riker whether he has ever made any tests showing what the difference of current was on macadamized and asphalt roads; that is, on ordinary days—not when there is mud.

MR. RIKER:—We have made some few tests in regard to that matter, and we find that on an ordinary Belgian pavement the power consumed is about the same as on the asphalt, and they are slightly less than good macadamized roads. Whether the friction of the large surface of the pneumatic tire on a macadamized road offers more resistance or not I do not know; but it seems to be so—that the Belgian block and asphalt offer about the same amount of resistance to the vehicle.

THE PRESIDENT:—May I ask the advantage of a bicycle wheel instead of an ordinary wheel?

MR. RIKER:—Do you mean instead of a wooden wheel?

THE PRESIDENT:—Yes.

MR. RIKER:—Well, the use that the wooden wheel has been put to has simply been to carry loads, and from the mere fact that every wooden wheel is run with radial spokes, the tendency is, when driving from your hub up, or your axle up, to twist the spokes off. We were using a radial wire wheel and with some tangential spokes to it, but we had an accident one night and we twisted the wheel all to pieces. The tangential spokes did not hold. And I think that in a motor vehicle it is absolutely imperative that wire wheels should be used, for a number of

reasons. We are building not merely a carriage but a machine now, and wood, as a general rule, is not very largely used in machine construction. We can get a lighter wheel and a very much more stable wheel with the wire construction, and there is no doubt but that the driving wheel should have tangential spokes instead of radial spokes.

MR. SACHS:—Some time ago I had occasion to look into the general art of motor vehicles, and I collected a lot of data relating to the subject. There are numerous essential features to be considered in the construction of a self-propelled road vehicle, aside from the motor. A great many of these considerations certainly do not refer particularly to the electric vehicle. In broadly considering the motor carriage, if I may consider it in that light under the present discussion, I find that the following features should be taken up: first, certainly, the design of the body, the motor, the gearing—unless the motor is directly connected, and I understand there is some work being done in the direction of direct-connected electric motors, the armature being directly connected to the wheel spokes. The controlling mechanism, in which direction electrical devices surpass all others. The disposition of the machinery in the vehicle plays a very important part. The general operation, care and attendance, is certainly most ideal in the electric vehicle. The cost of operation, facility of renewing the power-generating material, and the wear and depreciation of the power element. The disturbing and interfering qualities—these, as compared to other vehicles, are in the electric vehicle practically *nil*. The comfort and freedom from objectionable features to the occupants in the electrical vehicle are also ideal.

The appearance of the vehicle:—Mr. Riker's design, considered as a self-propelled vehicle, is certainly very handsome. Speed, grade-climbing ability, weight, and in fact all other elements which enter into a traction vehicle. Safety should come into consideration primarily. And here again the electric vehicle is certainly the most ideal.

As Mr. Riker has said, we cannot follow the horse-drawn vehicle in the construction of a motor wagon, for the simple reason that our problem is a radically different one. We have a traction vehicle and not a vehicle that is pulled or pushed; a vehicle that must furnish its own propelling energy from self-contained power.

Having chosen the general design of the vehicle body and the particular form of motor, the construction of the frame is important; and I find that both in Europe and this country the most advanced workers in this direction have adopted a tubular steel frame construction, somewhat of the bicycle tube type. I also find that there is a tendency, more or less, to devise a separate truck; a truck carrying the motor, and probably in some cases the entire power mechanism, and so equip this truck that it can be fitted with almost any design of vehicle body.

The point Mr. Riker made in regard to a low vehicle is certainly a correct one, because a vehicle that is self-propelling and is required to turn sharp corners, at high speed at times, cannot be top-heavy. It would very soon turn the other end to the ground if there were any high centre of gravity. Regarding the power, speed and capacity, I think there has been entirely too much attention paid to the question of high speeds. I find that the public interest that has been aroused on the possibility of traveling from one point to another at lightning speed. The electric or any other motor vehicle is not solely intended as a racing machine. I believe there are a great many other uses to be considered, and while I think that probably a very high speed vehicle will be of great value for certain purposes, and while high speed ought to be possible with certain classes of vehicles, the majority of the traveling will be done at probably 10 or 15 miles an hour. I do not consider a large power capacity in the motors, or too much of an ability to climb steep grades at maximum speed or high speed advisable. In fact, the device Mr. Riker has mentioned, similar to the back gear on a lathe, clearly shows that it is essential, even with an electric motor, with its very flexible power capacity above its normal rating—that even with such a motor it is better to apply some low-gear apparatus.

I find that there seem to be many mistaken ideas regarding where to place the most weight. Some inventors seem to have placed the entire weight of the machinery on the steering wheels instead of where it ought to be, and where it probably could be best applied—over the driving wheels.

The question of wheel construction, as Mr. Riker mentions, is a very important one, and the point he brought out is probably the principal one to be considered. The wheel of a motor vehicle does not only support weight and resist side thrusts, but has got to be used as a propelling agent. There is a force applied at or near the hub which must be exerted through the spokes to propel the vehicle, with a tendency to twist the spokes. The majority of inventors and builders have tried to apply the power as near to the rim of the wheel as possible. In fact, I found a device some days ago in which the motor was geared directly to a driving gear on the rim of the wheel, using a very high speed motor. I find that wheels have been built to rotate on a fixed axle; that is, the axle being rigidly attached to the vehicle body; and then I found some in which the entire axle and wheels rotate. Both of these constructions necessitate peculiar designs in the gearing, particularly when a single motor is used.

Regarding wheel tires, I find that pneumatic tires have been almost entirely used, although many of the European vehicles still adhere, particularly the gas vehicle, to steel tires, and in some cases wooden wheels. The peculiar advantage which is claimed for the pneumatic tire is its ability to give that slight

flexibility when passing over or striking obstructions directly, or on either side of the point of contact. It is just that slight flexibility which to a great extent prevents the steering wheels from being thrown out of their direction or from the stoppage of the vehicle in a great many cases. With a hard wheel the entire vehicle must be lifted over the obstruction, which means just such an expenditure of energy as is necessary to lift that weight over that particular height. Certainly a great deal of this is given back again when the vehicle drops on the other side, and a vehicle of this kind is continually striking such obstructions to run over. Now with a tire having some flexibility, such as the pneumatic tire, that slight flexibility in the material of the tire only necessitates the vehicle being lifted over a correspondingly smaller height. Side thrust pressure, on the bearing, is also materially decreased thereby.

The steering appliances, as Mr. Riker has stated, have been greatly diversified, and in some cases very little attention seems to have been paid to this particular item, as the fifth wheel method seems to have been retained in some vehicles; principally, however, the earlier types. The main point in the steering device seems to be to make the leverage between the pivotal points of the steering wheels and the point of contact on the wheel tire as short as possible, so that the energy, whether it be manual or otherwise, necessary to counteract that applied at the wheel rim when striking an obstruction, which is continuously necessary in running along a rough road or in steering, is as small as possible. The fifth wheel construction, or the pivoting of the single axle at a point midway between the wheels gives the maximum practical distance between the pivot and the point of contact. The tendency seems to be to use the construction adopted by Mr. Riker; mounting the steering wheels on short axles, each pivoted separately to an axle-tree, close to the wheel hub. In some cases the pivotal point of these short pivoted axles is on a line with the contact point on the wheel tire, so that there is practically no leverage at all to turn the wheel. When steering, this arrangement gives the vehicle a rather peculiar appearance, but this device is certainly most ideal. Front steering wheels are most generally used. There are some advantages claimed for the rear steering plan adopted in some vehicles, but I am not particularly familiar with them. In either case, whether front or rear, the tendency is to throw the weight of the vehicle onto the rear wheel.

Many elements must be considered in connecting the motor to the driving wheels. Many of these apply to the gas and steam motors only. Electric motors are certainly ideal. Nothing better can be hoped for, particularly with a single reduction or possibly direct connection between motor and wheels. In other motors a great many different devices have been used. Some of them may be enumerated as follows: Differently speeded gears

upon the main shaft, each individual gear being operated by a separate clutch and a cam lever or similar device for operating these clutches. By shifting the lever you throw in one or the other of the different gears and thereby obtain different speeds, or reverse the motion with the motor running in one direction. Instead of having a number of small clutches, one on each separate gear, one large clutch has been placed on the main shaft, and when it is necessary to change the speed, this clutch is thrown out and the gear shaft or sleeve shifted into another connection with the transmitting gears on the next shaft, and then the clutch thrown into connection again. This cumbersome arrangement is used in the principal European motor vehicles, chiefly in those employing the Daimler motor, which are being built by Messrs. Peugeot Freres, and Panhard and Levassor. Then there are different arrangements of separately speeded belts with either clutches or belt-shifting devices, cone pulleys and belt-shifting devices, loose belts and an idler, consisting simply of the transmission pulley and the power pulley over which a single belt runs, this belt being tightened or loosened by means of the idler, another belt being used for reversing. There are various arrangements of friction rollers and disks, and also a number of hydraulic and pneumatic gears. Some of the hydraulic gears use a pump of some kind operated by a motor, and the pump operates hydraulic motors geared to the wheel.

The brake of a motor vehicle certainly is an important factor. The tendency in this direction appears to be to apply the brake upon some separate brake pulley, upon either the motor shaft or upon some transmission shaft between the wheels and the motor. Braking upon the tires, particularly with pneumatic tires, very rapidly wears the tires and is not to be advised. With the electric vehicle, dynamic braking may be considered, and various electric devices can be devised for braking purposes.

I wish to mention, in view of the fact that we all consider the electric vehicle the most ideal, that there are various vehicles—steam vehicles included—that seem to have attained particular success. I may say that so great an authority as Sir David Salomons has lately taken up and developed a peculiar type of steam vehicle. This vehicle is known as the Serpollet steam carriage, and is most peculiar in its operation, being provided with a boiler of the instantaneous type. The tubes of this boiler consist of very heavy flattened steel tubes which are then jacketed over by an iron casing, and the flat opening of these tubes is probably an inch or two long and probably one-sixteenth of an inch high. The water used for generating steam—the boiler normally carrying no water whatever unless it is in operation—is forced into the boiler. This water is forced into the tubes by the hand pump at first, and steam is instantaneously generated, superheated, and then passes directly into the engine cylinders. After

the engine is in motion a small pump forces water into the boiler tubes. As the energy of the motor depends upon the amount of steam generated and consequently upon the amount of water forced into the boiler, the amount of water is regulated by means of a regulating valve, the pump-stroke remaining fixed, and the valve has a by-pass so that the water that is not forced into the boiler passes back again into the reservoir.

Regarding gas motor vehicles, it is unnecessary for me to bring up the various objections that have been urged against such vehicles. I may say that acetylene is being tried by various inventors, and I believe there have been some results obtained.

The bad features of gas vehicles may be enumerated as follows: They are not self-starting. They cannot start with any load. They give only full load and no excess of flexibility, and I think that this is one of the prime defects of gas motor vehicles—the fact that when going at the maximum rated capacity, if a sudden demand is made upon them for an excess of power above that which the motor is capable of, the vehicle stops short unless its momentum is great enough to force it over that obstruction. Certainly, in the majority of cases, probably it will run right over any obstruction that ordinarily will be met with. But there may be cases where bad roads will be struck, and similar instances, where, unless the speed gearing is changed immediately before striking such a place, the motor will stop short and it will be very difficult to start it up. I have noted this action particularly in some of these vehicles, and found that this occurred several times during a recent trip. Certainly the complicated gearing and the power lost therein, and that the motor must run continuously after once started must be noted. If you stop for a time, you have got that continuous running of the motor, pouring forth its fumes and deposits. I think that the promoters of this type of vehicle claim that they will and have already partly remedied this defect.

In engines using the heavier oils, the clogging up of the mechanism by deposits is to be particularly noted, as well as the odors which come from the engine exhaust. I would say, in regard to the many parts and the delicate mechanism of the gas engine, and the fact that an engine of this type ought to be built as heavy as possible for the duty it does, that it seems most peculiar that some of the European vehicles were able to go through the extremely long journeys which in some races in France amounted to hundreds of miles. They had some accidents, but still the same motor held out, with the necessary repairs. Some gas motor vehicles have been built which apparently operate with fair success. The Duryea motor vehicles in this country, and the Panhard and Levassor, Pengeot Freres, Benz and others in Europe, have attained quite some prominence.

I would like to ask Mr. Riker about one point in connection with electric vehicles, and that is this—why he prefers the single motor construction to the double motor construction. Certainly both have their advantages, and it may be interesting to have from him his reasons for using one or the other. I also wish to note that while the storage battery to-day is probably the only method adapted to supply electric energy to the electric motor for this purpose, that probably there may be something done in some other direction. I do not particularly allude to the possibility of generating electric current by direct chemical means or by means of heat or some similar method. We may consider in one sense the electric motor as an excellent, in fact as a prime method of tranforming electric energy into actual mechanical power. If we now devise some better method of actually generating the energy, some combination might be made which would eliminate the storage battery entirely. It may seem like taking away a bad element and substituting something worse; but there may be more in the direction of combining a small dynamo, driven by a gas engine, with an electric motor, than would at first appear.

MR. RIKER:—I do not think Mr. Sachs is probably aware, when he makes the remark about the steam carriage, that Count de Dion, who has probably done more experimenting with the steam vehicle than any other man, in an article the other day stated that he considered, for country work or very heavy work outside of city limits, that a steam tractor, as he called it, would be preferable to a vehicle carrying the motive power within itself. He also went on to state that he considered, after a number of years experimenting on both petroleum and steam vehicles, that he was working on an electric carriage for city work, and that his hopes for the future lay in the electric carriage.

In regard to the single motor equipment over the double, Mr. Sachs believes there is a word to be said in favor of both these constructions. I think the greatest point in favor of the single motor equipment is its first cost. Of course, in experimenting, we do not care what our carriage costs—the first one. But when we intend to put a practical commercial machine on the market, we have got to look at what we can sell these carriages for, and there is certainly a great difference between building two smaller motors and one larger one. The efficiency also is in favor of the single motor, and the weight is in favor of the single motor. The regulation can be accomplished with a single motor the same as with a double equipment, grouping the cells and changing it in that way. The only objection to the single motor equipment as compared with the double one is that in case anything should happen to the motor you have got, in the case of the double equipment, you have another one to come home with. But we found that the motors very rarely gave out; it was a question of something else—of which we did not have a double equipment.

MR. SACHS:—I must say that I did not notice this recent communication of the Count de Dion. But I am quite familiar with the class of vehicle that he has been promoting or working on. One vehicle is a very heavy affair; and in another case, a light tricycle. In both cases ordinary steam generators are used, carrying water at all times and a large amount of fuel. I hardly believe success will be attained in this direction for various reasons. In the first place, you have the generation of steam constantly going on which necessitates automatic firing. Automatic water feeding is essential, and blowing off steam when the engine is stopped would be absolutely objectionable. The danger of explosions exists to some extent unless all these devices work perfectly. Feeding and regulating the fuel automatically is a very difficult thing to accomplish satisfactorily even with oil fuel. In fact there are a number of other objections that may be brought against this class of vehicles. But when I spoke of steam vehicles I meant the type in which instantaneous generation or similiar boilers are used. I have not any exact data regarding the Serpollet vehicle, but from the information I can gather, this particular type of boiler is being developed, in France particularly, and numerous applications are being made, not only to motor vehicles but for other purposes. The results obtained from this type of steam generator have been excellent. I noticed some time ago in an article appearing in *Electrical Engineering*, written by Mr. Summers, the statement that the results obtained with the Serpollet steam generator very closely approximate those that can be obtained with compound condensing engines.

With this type of motive power, you at once obviate a great many of the objections to steam vehicles, and if the device does not depreciate too severely, is not too expensive, and is safe, as it would seem to be under ordinary conditions, I think that there is more than an ordinary chance of a vehicle of this type coming in for some success. I do not mean to say for a moment that I do not believe that the electrical vehicle in every way, is the ideal, if we leave the question of long distances out of the problem entirely. If we simply want to make a trip about town, or if we want a carriage for pleasure purposes to take a short ride for an hour or so, I do not think there is anything that can surpass an electric vehicle, allowing that a fairly satisfactory battery is adopted. We must however have vehicles to travel greater distances than the ordinary electric vehicle in its present condition is capable of, and I think that steam comes in for more than an ordinary share of the probability.

THE SECRETARY:—It may be of some interest to know that the type of boiler referred to by Mr. Sachs was brought to my attention seven or eight years ago in the form of a model. It was a very simple affair and the whole arrangement was easily understood, but I had heard nothing of it since and I supposed there was some practical objection to it.

We have with us this evening as a guest, Mr. Van Hoevenbergh, who is an inventor of a good many years experience and has taken an interest in this subject, not as a maker of electric vehicles, but as a prospective purchaser. I suppose that he may be a competent critic of electric vehicles as they appear to-day. I think that if he feels at liberty to say anything it would be of interest to the members.

THE PRESIDENT:—Being a customer, Mr. Van Hoevenbergh will probably be listened to with a great deal of attention.

MR. HENRY VAN HOEVENBERGH:—Mr. President, I would say merely that I came to listen to-night, not to say very much. But I have been looking for an electric vehicle for some time, and I have examined particularly into horseless carriages of all kinds. The objections we have heard to-night to them I think may be summed up very easily:—In that the steam vehicles are noisy; that they require an engineer of a good deal of experience to take care of them, and that they are very complicated—at least all that have been produced so far have been. The gasoline and naphtha vehicles have been pretty thoroughly tried, somewhat in America and more in France. In one of their races 50 vehicles were entered, and the race was from Paris to Marseilles and return, which was 1,005 miles. The wonder of it was that the greater portion of them made the entire trip successfully, but they ran across quite a number of obstacles that have not been brought to notice to-night. For instance, there were no less than 14 dogs sacrificed to science during that trip. One of those dogs was drawn into the machinery and so thoroughly ground up that the carriage had to be taken aside and thoroughly cleaned, and the bones and head and so forth completely eliminated before it could proceed. Another of the vehicles was charged by an enraged bull, and the engineer was tossed over into a field. Still another one was upset while disputing the right of way with a cow. The two retired from the race immediately. But leaving those out of account, the rest seemed to be very successful. One of them was tried by a member of a New York firm. It made the trip from Albany to New York and return, which practically wore the vehicle out, to begin with. It was said further that it frightened every horse that came within range, besides leaving behind it an odor that could almost be seen; so that naphtha vehicles seem to have to sit down in their turn.

To the electric vehicles, I think, with Mr. Riker and others, we must look for the successful vehicle of the future. All of those propelled by naphtha, steam, or any motive power of that kind, are always going to require very experienced men to handle them. They should really have an engineer and a driver besides, which is entirely impracticable for ordinary pleasure vehicles. But the electric vehicle, perfected as it undoubtedly will be in one way or another, would require just simply a driver,

who with one lever, which perhaps he might turn from side to side to guide his vehicle, and depress or lower it to regulate the speed, seems to be the vehicle that is going to be successful.

But there is another little side line that I have been interested in for some time that perhaps may be interesting to some present; that is, for fixed stage lines that go backward and forward every day over exactly the same routes, and that need never diverge more than to one side of the street or the other, the trolley might be adopted with advantage. The great disadvantages so far have been that in the first place there can be no ground return wire, of course. Therefore it must be a double conductor, and the double-conductor trolleys have been anything but a success so far. But it is possible to produce a double trolley vehicle which shall have these advantages; that in the first place it shall require but a single pair of conductors to propel it; that the vehicle shall have the whole range of the road, and that it shall be possible for two vehicles to pass each other on the same set of conductors. I know that sounds something like the train which was proposed by that crazy joker who died in France not very long ago, who proposed to the society of engineers there, in all gravity, a train provided with inclined planes, so that when two trains ran together, instead of knocking each other to pieces, one would simply run over the other, down the opposite side, and go on. That resemblance, however, is only fanciful. In the plan that I propose, the carrier is supported entirely upon one wire; it is clamped to it and runs upon it. It has an arm reaching over to the other trolley wire and making the other connection. One of the trolley carriers runs on one wire and one on the other. When the two come together the flexible arms just simply allow the others to pass, and they go on again, the connection being broken but for a very short time. That has been very successfully tried in laboratory tests; whether it will be a success when put on the road is another thing, although it looks very favorable at the present time. I don't know that I have anything else that would be of interest.

THE PRESIDENT:—I think it is rather important to know exactly what the problem is that is presented here. As I say, I have seen data that showed that the ordinary vehicle in city use and even in country use does not go more than thirty miles a day. So if you can get a vehicle that will run thirty miles in 24 hours, it will fulfil pretty much all that is required. But if anybody has any data about that, I would be very glad to hear about it.

MR. C. E. DURYEA:—It was quite late when I learned of this meeting. It was all I could do to get here, and I did not expect to make any remarks. There are some points presented however, that I would be pleased to take up. In the matter of construction, I wish to say a few words about the truck system. It is, I think, the cheaper plan to put the motor on the truck, leaving the body free. The truck is the handiest place to attach the

motor. It is also, I think, a matter of common observation that the new inventor in this line begins by putting the motor on the truck. But a little experience in carriage building, such as could be had by inquiring of some coach or stage builder, will show the inadvisibility of putting the motor on the truck because of the constant vibration to which the necessary machinery for the motor vehicle must be exposed, if so near the ground. For an example of what I mean, a prominent coach builder stated that he had seen a ¾″ iron bolt worn completely off by the rattling of the nut which happened to be loose, and yet the bolt was riveted over so that the nut could not fall off. It just jiggled around there until it cut the bolt off entirely. That is a specimen of what constant pounding over the road subjects a truck to. So if we are to build vehicles which will give satisfaction in use, we ought to put the machinery in some more satisfactory place—perhaps not so satisfactory to the user, but necessary in order to have the machine better cared for.

The question of odor is one that has been brought to our attention very prominently in the last few years, because we have been experimenting almost wholly with those odor-making machines—gasoline vehicles, and we have urged several things that we think are quite pertinent. We do not consider a gasoline motor so objectionable, in respect to odor, as the average horse, and we think that is a sufficient answer. We have a motor that we believe makes a less objectionable odor than that behind which the public are riding to-day, and we do not ask the public to ride *behind* our motor. In our vehicles they sit in front of the motor, and if they are behind the motor at other times, it is their fault and not ours. As a matter of fact we are pushing forward experiments in the line of eliminating odor, and we think we will succeed in getting rid of so much of it that it will not be objectionable.

The automatic feature that Mr. Riker spoke of is another point. Two or three times in my life I have needed small power and have been unfortunate enough to have to watch it myself, and I secured some of those things that were automatic—automatic steam engines. They were supposed not to need attention, and the great and peculiar feature I found with them was that when you were not looking at them they went wrong. The minute you turned your back something went wrong; the automatic part failed to work;—it was not automatic; and therefore, I believe, the more you can put the entire machine under the control of an operator the better, making it simple enough so that an ordinary intellect can comprehend the whole thing. We drive horses with two reins. We can drive a horse with one rein. We can drive a horse without any rein. We used to drive our oxen with nothing but a whip. But we find that two reins are better. We find it is better for a man to have a little more control of the animal. And I think the same is true of the

motor vehicle—the man ought to have full control of it at all times, and automatic devices are objectionable.

In the matter of wheels—when we took up the motor vehicle problem, we did not wish to introduce any more talking points, or rather objectionable points than we could help. We found that the ordinary horse vehicle had wooden spokes. They had been used ever since Adam, so far as we knew and were fairly good. We used them simply because we did not want to experiment with steel. I have been connected with the bicycle business a little bit for probably fifteen years, and we have used in that steel wheels almost wholly, and we find that the spokes of the bicycle cause more trouble than any other part, except possibly the pneumatic tire that came in recently, simply because metal does not stand constant vibration as well as something that is more elastic. A wooden wheel will stand more pounding over the road than a metal wheel. I do not care how tight you make your metal spokes, they will rattle loose, unless they are protected by very heavy tires. So, other things being equal, you will find that a wooden wheel will stand up better than a metal wheel. We set our spokes in wooden wheels without any spread at the base of the spoke. In the steel wheels we of necessity spread the spokes out, which places them in a much more advantageous position than the wooden spokes, and gives them an unfair advantage over the wood. If you were to put the wooden spoke in the same position, you would find it all right.

As to the matter of tangential spokes for driving purposes, it will be found that the strain on the spoke in the direction of rotation, due to applying the power, is less by far than the strain on the spoke endwise of the axle—sidewise of the wheel, as you turn a corner suddenly, or slip from one side of the street to the other, and any wooden spoke which will stand the sidewise strain necessary to carry a motor properly will also stand the driving strain applied by the motor. So I think wooden spokes will meet all requirements, and that unless the public demands them, there is no occasion to use metal spokes. I do not say this because we have heretofore put out wagons with wooden spoked wheels, for we have built some metal wheels and they are very good ones. We have not had any that "tied themselves in knots" yet. We have had enough experience with bicycle wheels that tied themselves in knots to avoid using steel wheels for motor wagons. But, personally I do not believe in the metal wheel.

The idea of carrying a gas engine, which is a very compact and convenient form of motor, and with it charging a storage battery which should be used then to operate the motor, so as to get the flexibility of speed desirable, has been used to some extent in street car service. A man by the name of Patton—I believe he hails from Milwaukee—has taken out several patents in that line and used that system to some extent, I believe, without any great degree of success. I do not know whether the fault is with Mr. Patton or with the system. I simply mention the fact.

The matter of recharging is one of great interest, it seems to me, to the public. If you are only going for half-an-hour's ride and can order up the carriage, it does not matter much what system you have, because almost any carriage will run half-an-hour if it is any good at all. But for private use, where a man must look out for that himself, it is, it seems to me, quite a question whether he has to put in several hundred pounds or perhaps a thousand pounds or so of new load, or whether he only puts in a few pounds. In the gasoline wagon, if it is only for half-an-hour or an hour's ride, there is no occasion to change the water supply, because the half-hour or hour's run in the gasoline wagon will not sufficiently heat up the water to necessitate any change or any addition. The fuel supply for half-an-hour or an hour is so small you could put it into your hat. Therefore there is little or no work required to put a charge into the wagon and none to take it out, because the motor takes it out. With the electric vehicle, it is necessary to change the batteries and replenish with new batteries, or else it is necessary to attach some sort of supply, and wait patiently. With the compressed air system of storage it is possible to walk up to a stop-cock, and, according to the popular idea, turn the cock and you are full. But with electricity it cannot be done quite so quick, which is the unfortunate part, it seems to me, of the electric wagon—the necessity of time for charging. We have given some thought to the electric wagon, but the experience of some companies who have spent several hundred thousand dollars in trying to adapt electric storage batteries to street car service has discouraged us, and our own experience with electricity has not been favorable to batteries at any rate.

The question of steam as compared with gasoline or with electricity has seemed to us to be in favor of the gasoline rather than the steam. While it is true that steam is a very flexible means of operating, it takes probably twice the amount of fuel to generate the steam, even with the Serpollet or other instantaneous generator, than it does to get the same power with the gasoline engine, and that being true, the item of expense alone would favor the gasoline, although the expense is not worth much consideration in the motor vehicle. Not only must you have more fuel, but you must have more water, unless you have some form of condenser, and none of which I know are of any account for wagon service. In boat service we can get a condenser because we have water. In wagon service we have no water, especially on a hot day in summer. For that reason gasoline is favored.

Light weight seems to be the greatest desideratum of a motor vehicle. The reason why motor vehicles have failed for the last century is almost wholly because their weight has been so great compared with their power; that they have not been practical; and that which offers the greatest power with the least weight

would seem to-day to be the most reliable device, regardless of what it is. Going on that line we have stuck to the gasoline vehicles, because we believe they are by far lighter than either steam or electricity for a given power.

MR. RIKER:—Taking up the subject of Mr. Duryea's first remark in regard to putting the motor in the body of the carriage and not in the truck, I do not think that his judgment is quite sound there. I know that in electric railroads, when they were first proposed, the motor was placed in every conceivable spot. First it was put on the front platform of the car, and then it was put in the middle of the car, dropped down and slid up, and finally ended by being placed right straight on the axle, and that is the accepted design to-day, and I do not think that the electric motor builders or railway people would go back to putting the motor up inside the car or suspending it on the running gear. They would prefer to go right straight down onto the axle. I know of plans proposed and used by some concerns in which they use a spring suspension to do away with jar and vibration, but that is not to save the motor as much as it is to save the rail joints. The pneumatic tire does away with a great deal of vibration, and it would seem to me that it was not the fault of the material or the fault of the mounting so much as it was that the workmanship was not as good as it should have been, to have vibrated that belt off in the manner he stated. I have known such things to happen, but I think it is more the exception than the rule.

With regard to the odor which Mr. Duryea spoke about, I thought that was the thing we were trying to get rid of when we got rid of the horse—that was one of the objections to the horse. We want to get rid of that odor entirely. That was one of the features that the horseless carriage offered—that there were no unpleasant odors connected with it.

As regards an automatic device or an automatic machine, I think Mr. Duryea has lost sight of one of the prettiest automatic pieces of machinery that I know of to-day, and that is the naphtha launch. There is an engine which when once started will run and take care of itself with absolutely no attention whatsoever. All the man has to do is simply to light the fire, turn on his valve and the engine will run until he wants to stop it. There is no need of looking at any pressure gauge or anything else. It is entirely automatic. Now whether such a device can be applied to a motor vehicle without involving a great many difficulties, I do not know. The fact of not having water for condensing purposes—there would have to be some other system used; but it seems to me that a system of air could be used similar to the condensers that are being proposed now and are used for electric lighting stations. The question to my mind is simply in regard to the electric vehicle being a success, as I mentioned to-night in opening this discussion, that the battery was responsible for all the trouble of the electric vehicle, and I think the battery people

ought to take the subject up seriously and not treat it as a sort of joke. The storage battery of to-day is not constructed for traction work. It is all very nice when you stand it down in the cellar and light your house or run a large central station, or put it on shipboard, but for traction purposes the type of cell has got to be radically changed.

One of the points Mr. Duryea made was the length of time required to change or charge the storage battery carriage. The time required to change batteries in an electric carriage is about a minute. The batteries slide in on racks, making connections by the simple closing of a switch, and I cannot see any very great objection to that. But I am very greatly interested in some tests now; in fact I made a test to-day on something that looked very promising in the storage battery line. We charged the cell up in three and a half hours at a very high rate, and we discharged that same cell in about two hours and three-quarters with an efficiency of about 65 per cent. This cell, it seems to me, can be so arranged that it will last indefinitely. It is simply a question of the conductor in the positive plate wearing out; and a new one can be substituted. In fact we know that the active material in a storage battery lasts forever. It is just simply that the material becomes loosened from the support plate and falls down into the cell, and I believe abroad they propose picking that material up and putting it back again, and I can see no reason why this cannot be done in a battery for electric vehicles.

Another point that has to be brought up in all these things is what we are going to get for the carriages after we build them. In going over these different subjects we find, so far as we can determine now, that the electric vehicle is the cheapest vehicle to construct, and as the President remarked to-night, 30 to 35 miles is a good range for any vehicle. In fact I believe the large department stores in New York City figure on 25 miles as a day's trip for their delivery wagons. That is the greatest number of miles that they run, and it would seem that such a system as they use would be probably the best data that we could gather on the subject of what the length of a run would necessarily be. In all probability no private person is going to use a carriage that he wants to run over 20 or 25 miles a day. The question of running further is simply a question of putting on some more batteries or making the carriage into a sort of railway train. I think the generally accepted practice is when anybody wants to go in this country over 25 or 30 miles they get on board a train, and they take an express train at that. When they go out for a drive they do not go that number of miles.

I think that the electric carriage to-day seems to have a brighter future than any of the others for its use, and that is for a light pleasure vehicle. Probably for heavy omnibuses and large delivery wagons something of the description of steam or some vapor or probably petroleum engines will be used; but I think for a pleasure vehicle the electric carriage is the coming machine.

MR. DURYEA:—This is a progressive age. One vehicle in particular that we can point to has gained its popularity by its speed more than anything else. That is the bicycle. People go out riding on bicycles for pleasure, and ride as far as 100 or even more miles in a day. So that a man who expects to get pleasure by driving only at the rate of 25 miles a day is certainly very slow in his requirements. We find that men pay high prices for fast horses. Why? Simply because they can drive a good distance in a little less time than the other fellow, or because they can drive further than other men. The same with motor vehicles. If we are going to build vehicles that people will be willing to pay for, they must be capable not only of high speed but of continued high speed. A vehicle that would not cover 25 miles in at least half a day I would not consider worth putting out as a motor vehicle, because I would not deem it greatly in advance of the horse. I myself have driven 50 or 60 miles even with a single horse, to a light buggy, in a day, without damaging the horse, and when a man has driven that distance over a rough country, he is usually anxious to finish the last part of the journey pretty quick. We have frequently finished 50 miles in an afternoon and had some time to spare, in motor vehicles on New England roads. The exhilaration of coasting down one of those hills at 20 or 25 miles an hour is second only to coasting it on a bicycle or coasting it in winter on a sled. And that is where the price for motor vehicles is to come in—the fact that we can have a great deal higher speed than with the horse. The reason why civilization is displacing the horse is because the horse is too slow. The reason why the horse displaced the ox, a few generations back, was because the ox was too slow. So if we are to build motor vehicles to take the place of the horse, they must be faster than the horse; and the fact that a vehicle will travel 25 miles on a business trip is no proof that the motor must not do more. If it does more, the people will take it and pay more for it. That is the way thespeed problem looks to me.

In the matter of charging, we work a horse for half a day. If a vehicle will not stand half a day's work without charging again, then it is not properly equipped for capacity. The time of charging must not be confounded with the time of changing batteries. It is one thing to take them finally back to the starting point and be able to slip in another set of batteries. It is an entirely different thing to be half a day away from home and wish to be back, and the only thing available a Western Union telegraph wire or perhaps some private battery stored around somewhere.

Those considerations have presented themselves to us whenever we have turned our attention towards electric wagons, and therefore we have preferred to use a vehicle which we could load up with ordinary stove gasoline, which could be had at most grocery or stove stores, or on a pinch run home on kerosene.

Our vehicles will go on kerosene if it is necessary to do so. We think that is quite an advantage in favor of the gasoline vehicle.

I have never used the naphtha launch itself; but I have used several varieties of launches having automatic steam engines, which, so far as I know, are just as reliable and just as automatic as an engine using some other liquid as a source of heat.

SECRETARY POPE (in the Chair):—The question of delivering and transporting merchandise in our cities, is one of great importance, because we all know, or should know, that it is the most expensive part of the freight traffic to-day. When the Singer Sewing Machine Company moved their factory from New York City to Elizabeth, where they had means of direct shipment from the factory, loading machines directly on the cars, it was found that they could place them in Chicago, in bulk in the cars, for what it cost to put them on the wharf in New York ready for shipment, because they dispensed with boxing and the cost of cartage to the train, and we all know that the cost of cartage is of greater importance than the cost of freight, much as we growl about the latter. We are also approaching the question of individual passenger transportation. We find that what is wanted to-day in our cities, in order to give the best facilities for transportation, is to provide exclusive privileges for bicycles on certain streets, and storage for them where the people work or where they lodge. Then each individual may be independent, a large part of the year, of all other kinds of transportation; and consequently, his own ability to go, as Mr. Duryea has said, a hundred miles a day, would be certainly one of the satisfactions of owning a machine of that capacity, even if a person did not wish to use it to that extent. It is the ability to do a thing of that kind if it becomes necessary, that is satisfactory; not that you wish to go a hundred miles every day, but that you have a machine with which you can go a hundred, or a hundred and fifty miles if necessary. Therefore the machine ought to have that margin in order to meet the demands of the present day.

In regard to getting supplies of kerosene at every point—that is what we hope for in respect to electricity one of these days—that its use will become so universal that wherever we may be, we may have electrical facilities, or current for charging storage batteries. One of the drawbacks to the use of electric heating and electric motors for a great many purposes, is the lack of opportunity for obtaining current in a great many cases. We can see to-day, from the example that is being set at Niagara, and which now obtains at one or two points in the west, notably at Great Falls, Montana, how universal the application of electricity becomes when we have the facilities for obtaining it at every point in the city. This will be the case—how soon, of course, is visionary. But we all realize in metropolitan life how much depends upon the convenience of all these improvements that are being brought to our attention.

[Adjourned.]

"The work contains much valuable information, which is here published for the first time, and owing to the simultaneous sessions of the different sections of the Congress, many of the papers are new, even to those who attended the sessions."—*Electric Power.*

PROCEEDINGS

OF THE

International Electrical Congress

AT CHICAGO, 1893.

Published by the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

PRICE, $3.00.

This volume is the only complete and authorized edition of the proceedings of the most important electrical gathering ever held in America.

It contains the official report of the

CHAMBER OF DELEGATES,

and the frontispiece is a reproduction of the only group negative of its members in existence.

The papers read before the Congress are fully illustrated, and with the verbatim discussions, form a book of great historical and technical value. It contains 522 pages, and its publication was under the supervision of a special Committee of the Congress, and a similar Committee appointed by the Institute.

Among the contributors and participants in discussions appear the most distinguished names known in electrical science.

The book will be sent by express or mail prepaid on receipt of the price strictly in advance.

Cloth, $3.00.
Paper uncut, $3.00.
Half Morocco Cloth Sides, $4.25.

Address,

American Institute of Electrical Engineers,

26 CORTLANDT ST.,

Telephone 2199 Cortlandt. **NEW YORK CITY.**

"A full history of this interesting and important congress of electricians, and a publication of the many papers presented to it by some of the foremost electrical engineers of the world."—*Engineering News.*

"The report of the Chicago Electrical Congress constitutes a volume which has a distinct value, not only as a record of what was accomplished at that important meeting, but as a memento of a gathering such as will probably not be brought together for many years to come."—*Electrical Engineer.*

"Of very great interest and value to all who have to do with electricity."—*American Machinist.*

"The proceedings of the INSTITUTE have acquired so high standing that any of their publications may be pronounced a sine qua non in every scientific library. As a matter of course, the present work represents the highest grade of publication in its own line. We may note that this volume is largely given up to alternating current work, and thereby the tendency of the day is indicated."—*Scientific American.*

EDWARD P. THOMPSON, M. E.

PROF. WM. A. ANTHONY,

TEMPLE COURT, - - NEW YORK.

United States and Foreign **Patents**, Electrical Specifications, Expert Advice and Testimony.

Price of this space,

$12.00 per annum.

DAY'S KERITE

Highest Grade of Insulation for

Electric Wires and Cables.

—GRANTED:—

Two Highest Awards World's Fair, Chicago, Ill., 1893.

W. R. BRIXEY,
SOLE MANUFACTURER,
203 Broadway, - New York.

J. E. HAM,
General Agent

EXPERIMENTAL AND MODELWORK,

Electrical Apparatus and Fine Machinery,

Special Tools, Patterns, Gear Cutting, Specialties, Repairs, Etc.

E. V. BAILLARD, 106 Liberty St., N. Y.

TRANSACTIONS WANTED.

I have orders on file for volumes 3 and 5 (1886 and 1887) Transactions A. I. E. E., wanted by new members and libraries to complete their sets. The following prices will be paid for copies in good order.

Volume 3, - - - - **$2.**
Volume 5, - - - - - **$4.**

Address, RALPH W. POPE, Secretrry.

McINTOSH, SEYMOUR & CO.

AUBURN, N. Y.

—BUILDERS OF—

Engines FOR ALL Electrical Purposes.

THE AMERICAN BELL TELEPHONE COMPANY

125 MILK STREET, BOSTON, MASS.

This company owns Letters-Patent No. 463,569 granted to Emile Berliner November 17, 1891, for a combined telegraph and telephone, covering all forms of microphone transmitters or contact telephones.

Information Regarding Transactions.

The monthly parts distributed to members and subscribers during the year, are not intended for binding, but simply for the use of readers, as the work of the Institute progresses.

After printing the monthly, the papers and discussions are revised, repaged, and the sheets for the annual volume printed from the corrected type, and laid aside till the close of the year. As the index is made for the volume and **not** for the monthly parts, the complete volume sent at the end of the year becomes the permanent record. Upon its receipt the monthly parts are superfluous. They may be returned to this office at our expense, as there is a continual demand for separate copies of papers.

RALPH W. POPE, Secretary.

COPPER WIRE TABLE.

This table gives the WEIGHTS, LENGTHS and RESISTANCES of cool, warm, and hot wires of

MATTHIESSEN'S STANDARD CONDUCTIVITY,

for both Brown and Sharpe (A. W. G.) and Birmingham Wire Gauges (B. W. G.)

It was prepared by the Institute Committee on Units and Standards, personally revised by the individual members of the Committee, and issued with the October, 1893, number of the TRANSACTIONS, forming a part of Volume X.

Mailed separately, price 10 cents.

RALPH W. POPE, Secretary,
26 Cortlandt Street,
New York City.

Contents of Vol. XII. 1895.

CATALOGUE OF MEMBERSHIP. ON THE UNITS OF LIGHT AND RADIATION. By Alexander Macfarlane. THE BEST METAL FOR FIELD MAGNET FRAMES. (Illustrated.) By Alton D. Adams. No. 1, January. RAIL-BONDING AND ITS BEARING ON ELECTROLYTIC CORROSION. (Illustrated.) Communicated on by Geo. P. Low. NOTES ON RECENT ELECTRICAL ENGINEERING DEVELOPMENT IN FRANCE AND ENGLAND. By H. Ward Leonard of New York. No. 2, February. A METHOD FOR PREVENTING ARMATURE REACTION. (Illustrated.) By Harris J. Ryan and Milton E. Thompson. No. 3, March. RESONANCE IN ALTERNATING CURRENT LINES. (Illustrated.) By E. J. Houston and A. E. Kennelly. UNDERWRITERS' RULES. By W. A. Anthony. No. 4, April. OBITUARY.—George M. Phelps. LEONARD ON EUROPEAN ENGINEERING. (Chicago Discussion.) RYAN AND THOMPSON ON ARMATURE REACTION. (Chicago Discussion.) HOUSTON AND KENNELLY ON RESONANCE. (New York Discussion.) ANTHONY ON UNDERWRITERS' RULES. New York and Chicago Discussion. PRELIMINARY REPORT INDEXING COMMITTEE. REPORT OF COUNCIL, SECRETARY, TREASURER AND TELLERS. No. 5, May. PROPERTIES OF FUSE METALS WHEN SUBJECTED TO SHORT CIRCUITS. By W. E. Harrington. THEORY OF THE GENERAL ALTERNATING TRANSFORMER. By C. P. Steinmetz. LOCATION OF GROUNDS IN ARMATURE, FIELDS, ETC. By Clarence E. Gifford. THE SUBSTITUTION OF ELECTRICITY FOR STEAM IN RAILWAY PRACTICE. By Dr. Louis Duncan. COMPOUNDING DYNAMOS FOR ARMATURE REACTION. By Prof. Elihu Thomson. ELECTRIC POWER IN FACTORIES AND MILLS. By Dr. F. B. Crocker, W. M. Benedict and A. F. Ormsbee. SOME FEATURES OF ALTERNATING CURRENT SYSTEMS. By C. P. Steinmetz. SOME OBSERVATIONS ON A DIRECT CONNECTED 300 K. W. MONOCYCLIC ALTERNATOR. By Profs D. C. Jackson and S. B. Fortenbaugh. THE COST OF STEAM POWER. II. By Dr. Chas. E. Emery. PHASING TRANSFORMERS. By Chas. S. Bradley. REPORT OF PROF. R. A. FESSENDEN, No. 6 AND 7, JUNE AND JULY. THE CAUSE OF DEATH IN ELECTRIC SHOCK. A. M. Bleile, M. D. LONG DISTANCE TRANSMISSION AT 10,000 VOLTS. (Illustrated.) By G. H. Winslow. ALTERNATING CURRENT CURVES. (Illustrated.) By C. P. Emery. NOTES ON THE RECONSTRUCTION OF A SMALL CENTRAL STATION PLANT. (Illustrated.) By F. L. Pope. EXISTING COMMERCIAL APPLICATIONS OF ELECTRICAL POWER AT NIAGARA FALLS. (Illustrated.) By W. L. R. Emmet. Nos. 8 AND 9, AUGUST AND SEPTEMBER. LOCAL ANNEALING OF HARD FACED ARMOR PLATES. (Illustrated.) By Hermann Lemp, Jr. THE RATING AND BEHAVIOR OF FUSE WIRES. (Illustrated.) By W. M. Stine, H. E. Gaytes and C. E. Freeman. No. 10, October, 1895. STORAGE BATTERY APPLICATIONS. (A Topical Discussion.) No. 11, November, 1895. CATALOGUE OF MEMBERSHIP, No. 12, December, 1895.

Contents of Vol. XIII, 1896.

ELECTRIC ELEVATORS, WITH DETAILED DESCRIPTION OF SPECIAL TYPES. (Illustrated.) By Frank J. Sprague. No. 1, January. A NEW METHOD OF STUDYING THE LIGHT OF ALTERNATING ARC LAMPS. (Illustrated.) By Prof. Wm. L. Puffer. No. 2, February. RECENT DEVELOPMENTS IN VACUUM TUBE LIGHTING. (Illustrated.) By D. McFarlan Moore. No. 3 March. PROCEEDINGS ANNUAL MEETING, May 19th, 1896. STANDARDS OF LIGHT. REPORT OF SUB-COMMITTEE. (Illustrated.) By Dr. Edward L. Nichols, C. H. Sharp and C. P. Matthews. No. 4, April. AN ANALYSIS OF TRANSFORMER CURVES. (Illustrated.) By Charles K. Huguet. No. 5, May. EFFECT OF TEMPERATURE ON INSULATING MATERIAL. (Illustrated.) By Geo. F. Sever, A. Monell, and C. L. Perry. AN EXPERIMENTAL STUDY OF ELECTROMOTIVE FORCES INDUCED ON BREAKING A CIRCUIT. (Illustrated.) By F. J. A. McKittrick. Nos. 6 and 7, June and July, 1896. THE RECONSTRUCTION OF THE PLANT OF THE CHICAGO BOARD OF TRADE. (Illustrated.) By Bion J. Arnold. PRESENT STATUS OF THE TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY. INAUGURAL ADDRESS by President Duncan. Nos. 8 and 9, August and September, 1896. ELECTRIC TRACTION UNDER STEAM RAILWAY CONDITIONS. A Topical Discussion. VOLTS vs. OHMS. SPEED REGULATION OF ELECTRIC MOTORS. (Illustrated.) By H. Ward Leonard. No. 10, October, 1896. CATALOGUE OF MEMBERS. No. 11, November, 1896. VOLTS vs. OHMS. Discussion, November 18th, 1896. THE RONTGEN RAY, AND ITS RELATION TO PHYSICS. A Topical Discussion, December 16th, 1896. No. 12 December, 1896.

Contents of Vol. XIV. 1897, far as Published.

ELECTRICALLY DRIVEN VEHICLES. A Topical Discussion. No. 1, January, 1897.

BOUND VOLUMES FOR SALE.

The following volumes of the TRANSACTIONS may be purchased by those who desire to complete their files.

				PRICE.
1884.	Volume 1, (150 pages.)	Paper binding only		$2.00
1885.	" 2, (106 ")	" " "		2.00
1887.	" 4, (232 ")	" " "	(reprinted)	2.00
1888.	" 5, (485 ")	Cloth binding		5.00
1889.	" 6, (518 ")	" "		5.00
1890.	" 7, (474 ")	" "		5.00
1891.	" 8, (608 ")	" "		5.00
1892.	" 9, (828 ")	" "		5.00
1893.	" 10, (668 ")	" "		5.00
1894.	" 11, (877 ")	" "		5.00
1895.	" 12, (683 ")	" "		5.00

The last eight volumes may be had in half-morocco binding for $1.00 extra.

Address,

RALPH W. POPE, Sec'y.,
26 Cortlandt St., New York.